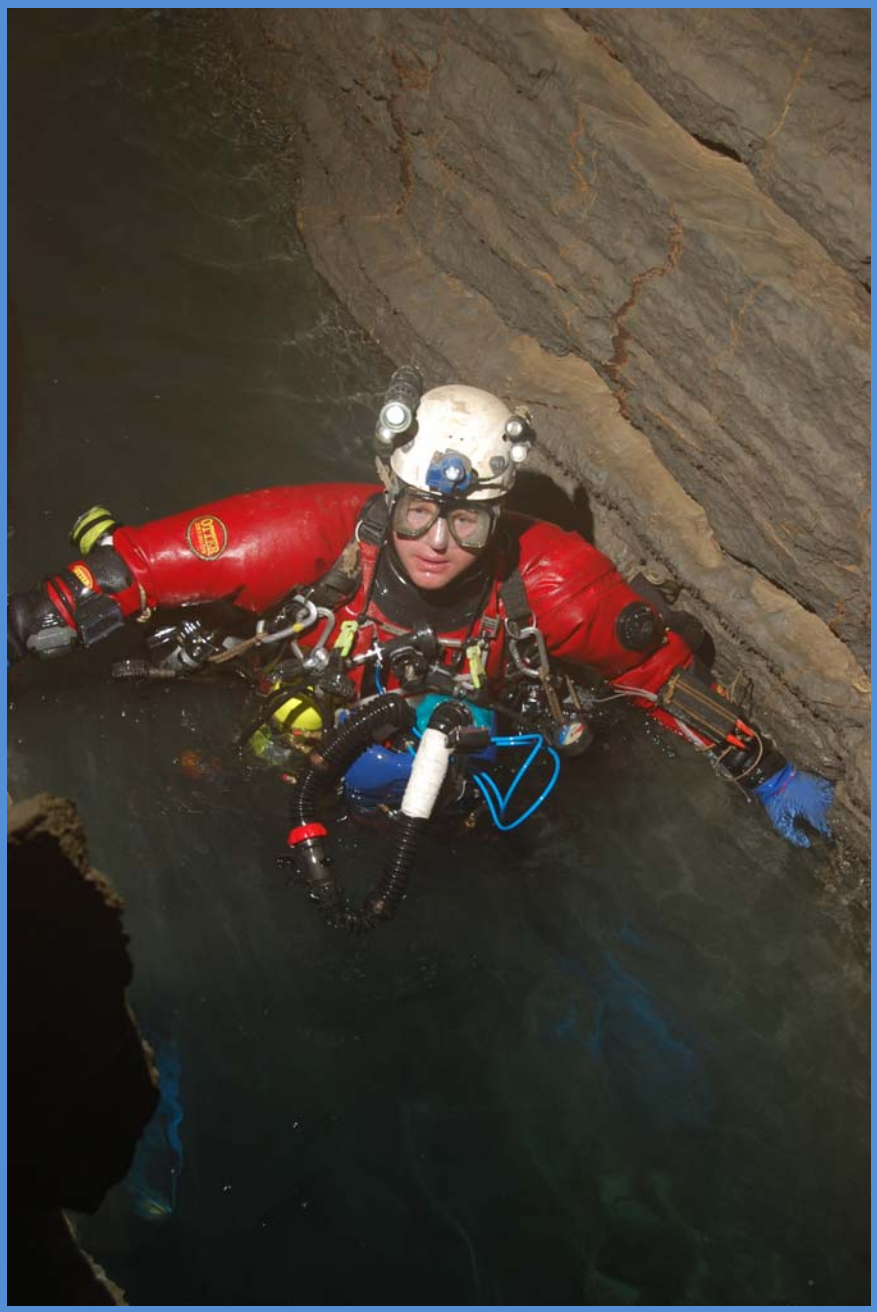
Official Report

Castleguard Cave Diving Expedition 2009



By Martin Groves

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Introduction

Castleguard Cave is Canada's longest known cave and is renowned world-wide as the premier example of a cave which extends beneath an active Icefield, the Columbia Icefield. The cave entrance has been well known since 1921 and was often visited by horse outfitter. Exploration beyond the 8m pitch however only began in 1967 and many epic explorations up until the late 1980s extended the cave significantly towards its current length. Much of the known cave is a hydrological relic of the drainage system beneath Castleguard Mountain. Spring and summer melt-water, however, overwhelm the active drainage and cause the downstream end of the cave to flood and the current entrance to resurge in a spectacular manner; this being the main fascination to draw early visitors to the cave. During the 1967 explorations two explorers Boon and Thompson were temporarily trapped, exploring the cave whilst caught by a flood pulse. Since then access to the cave has been restricted to winter and early spring.

The fossil system has been extensively explored from the entrance to the so called headwater complex where the cave takes on a dendritic nature and splits into a complex series of passages; a number of these end in ice-plugs several hundred meters beneath the Columbia Icefield. The ice-plugs are a unique feature of Castleguard Cave. One lead which is relatively near to the entrance is only partially explored, and still wide open. This is the sump at the end of the Boon's Blunder passage. The difficulty with exploring this obstacle is that diving equipment is required. The sump is the source of the water which causes the cave to flood during the summer and hence is a passage of significant interest. It could provide a window into the postulated Castleguard II system which must exist beneath the known cave, and could also provide access to a dry extension similar to the known cave, but accessible only to divers. The only way to solve the mystery of what lies beyond the sump is to dive it.

The sump was first dived in 1986 by David (Is it Keith instead of David, I've read both names in different publications, you should check) Sawatzky and John Pollock as part of a well funded Derek Ford expedition. Over the course of three dives they explored the sump for a

distance of 125m from the dive base. They never returned to extend the exploration beyond this.

The purpose of this document is to provide a formal record of the history and methodology of a combined UK and Canadian attempt to dive the Boon's Blunder sump.

Dr Martin Groves
May 2009

Background

1) Motivation

The genesis of the idea to plan to dive the sump at the end of Boon's Blunder came to the author not by design but more by chance. Whilst discussing with a couple of caving friends the desire to maybe move away from cave exploration for a while and learn the skills to travel in polar regions, or better still to combine the two disciplines on a caving expedition, Castleguard Cave was mentioned. Following a visit to the South Wales Caving Club library the Atlas of the Great Caves of the World stated that there was a partially explored sump in Castleguard Cave, the book was dated 1990 (check); surely it had been pushed beyond this. The power of the internet soon confirmed that it had not, when Dan Green's superb map of Castleguard Cave was studied. Represented by a tantalising dark blue passage it was evident that the sump had not been pushed past its 1986 limit. Given the width of the passage it looked like an object of quite sizeable proportions. As an enthusiastic cave diver who relishes adventure and learning new skills I just had to find out more about the logistics involved and the possibility of pursuing this most exciting lead.

It was with some apprehension that contact was made with Ian McKenzie of the Alberta Speleological Society (A.S.S.), not because the caving or the diving looked particularly difficult but because I may be laughed at, not being able to ski. Ian's reply was cautiously optimistic stating that it was a good objective provided one is up to the task. Things progressed rapidly as Ian was clearly keen on the idea of the lead being pushed. Contact was made with Greg Horne of Parks Canada (P.C.) and discussions began around the issues to be faced. It soon became clear that the dive was not the sort of project to be taken lightly and that the logistics involved were huge; it was decided that the best way forward was to plan a reconnaissance trip to assess the problems. This was to take place the week after Easter 2008. From a personal point of view this opportunity was a huge relief as it would give me the chance to acquire the skills necessary to actually get to the cave and to see if I was up to it.

2) Reconnaissance Trip

Ian and Greg put a huge amount of effort into organising the reconnaissance trip and for that I am truly grateful; all I had to concentrate on was getting as fit as possible prior to the trip. It was with trepidation that I set off from the car park at the Big Bend on the Icefields Parkway at first light, a heavy pack on my back, and having spent a total of only six hours or so on skis. I skied into the cave guided by Chas Yonge and Katie Graham. Fortunately the ski to Castleguard Cave is more slog than technical and the fitness gained by running numerous mountain marathons over the proceeding year saw me through without any issues; a huge relief, to say the least.

The following day saw the first trip into the cave. The ice levels were still very high with the lead in to the 8m pitch near the entrance a pure ice ramp. To secure people whilst accessing the pitch head a back up line was improvised using a knot wedged in a crack; maybe a further P-Hanger should be placed as a back up for the future. Beneath the ladder the next obstacle was the infamous 200m long ice-crawl. One section of the ice-crawl required digging with an ice-pick to pass, with only 4 inches of airspace above the tightest part initially. Even after digging, it was a tight squeeze. The route to the sump is not as straightforward as the survey suggests and the team failed to locate it on that day. Parks Canada staff Greg Horne, Joe Storm and Jurgen Deagle arrived at the cave that evening. Greg had planned to combine the reconnaissance trip with some work on invertebrates he had been studying in the cave. Chas and Katie departed the following morning with the remaining four travelling to the Subway to look for invertebrates, helping Greg with his work. A number of traps were set in the Subway to see if any new life forms could be caught. Back at camp later that evening Ian McKenzie and Don Kulak arrived with the plan of actually getting to the sump the next day. We got to the sump, but think we found the most torturous way there; luckily the return route was, by far, more civilized. After all the crawling on hands and knees the passage briefly opens up to standing height before terminating at a 10m long by 1.5m wide rift which is filled with beautiful turquoise water, a cave diver's dream. It could be clearly see that at the far end of the sump was a large shaft that dropping to a considerable depth and it was amazing to see the twenty year old dive line from the previous explorers still attached and apparently secure. I explained to Greg

that this could pose a potential problem for prospective dives because surely the summer floods would have destroyed the line in the main tunnel and there could potentially be a huge coil of line waiting to ensnare any diver who entered the sump. Ideally I should like to be starting from a 'blank sheet' in a line free sump. The following day Ian, Don and I left the cave with Greg, the others remaining for another day to check the traps.

The view of all involved was that the reconnaissance trip was a success. Not only had it given a true insight into the logistics required to objectively tackle the prospect of organising a trip to dive the sump, it had provided a good opportunity to meet representatives from P.C. and the A.S.S. both parties would play a critical role in any future plans to organise an expedition to dive the cave. On a personal level the trip provided a huge boost because it had given me the chance to develop the skills required to reach the cave, a fundamental feature of any future expedition plan!

It was decided that a formal application would be made for access to the cave to conduct dive operations over Easter 2009. Before submitting the formal application a period of consolidation was undertaken to reflect upon the logistics of tackling the objective and also to formulate contingency plans in the event of any incident during the course of the trip.

Trip Planning

1) Logistics

It is absolutely essential that before proceeding to apply for formal permission and recruiting personal support for a dive project that the lead person has a sound game plan in mind. Such plans are always open to amendments and adjustments as events unfold, but an overall framework is certainly required. From the early stages the following conditions determined how the dive would be conducted: -

- Man-haul all the gear to and from the cave;
- A solo lead diver to conduct all explorations;
- A reserve diver on the team in case the lead diver was unable to dive;

- The use of a rebreather to reduce the number of cylinders to be carried to the cave;
- The expedition time frame was to be a two week period around Easter.
- The previous divers, in 1987, had access to a helicopter; however from a personal point of view a more puritanical approach was required with things done the old fashioned way to have minimal impact of the surroundings. An added bonus was that this approach would keep the cost of the trip down, avoiding the application process for a helicopter permit. In addition, the challenge of skiing in and man-hauling kit in polar explorer style was a big attraction when recruiting the UK team who get limited opportunity to under take such activities.

Solo dive exploration is fairly much the norm for members of the Cave Diving Group (C.D.G.), but is very much an alien concept to many open water divers. Perhaps the most fundamental principle of cave diving is one of self-reliance and in the potentially hostile conditions of a confined space where visibility could be very limited often another diver is a liability not an asset. No further progress would be made in the exploration with two divers, twice as much equipment would have to be carried to the cave and there would be little benefit in terms of safety. From a personal viewpoint the only viable option was a single lead diver. The idea of alternating divers did not appeal either, from personal experience one diver who becomes more and more familiar with a dive site over several dives is far more effective than several divers diluting the exposure to the site. That said, it is still important to recruit a reserve diver on the team, just in case the lead diver, for some reason cannot dive; a wasted trip would not be to any one's liking.

Having carefully studied the dive report of the previous explorers, the principle difficulties to be anticipated in conducting the dive are as follows, in order of importance: -

- The anticipated water temperature of 1-2^{o}C;
- The dive is at an altitude of 2100m which impacts on decompression obligations;
- Glacial silt is expected to ruin the return visibility.

Each of these factors had a major effect of the dive planning and the approach to be used and they are referred to time and time again, however the most significant effect they had on the dive plan was the decision to use a rebreather. Although rebreather are becoming more common in mainstream diving it is important to outline the principles behind their operation and to explain how a rebreather significantly helps tackle the three fore mentioned problems.

Rebreather Basics

On conventional open-circuit scuba usable gas is wasted on each exhalation. The vast majority of the bubbles seen coming from a diver's mouth contains very little waste products (carbon dioxide) and the volume of wasted gas increases proportionately with depth. A rebreather takes a fundamentally different approach to diving where the exhaled gas in not expelled into the water but passed through a canister of chemicals which absorb the unwanted carbon dioxide. The gas then passes into a breathing bag and back to the diver's lungs when an inhalation breath is taken. Any unused oxygen and all of the nitrogen is recycled and passed around the loop to be reused by the diver. Obviously some of the oxygen is used by the diver and therefore extra oxygen must be added to the breathing loop, the oxygen levels are carefully monitored using an electronic meter. The reaction between carbon dioxide and the scrubber chemicals is exothermic, this means the diver breaths significantly warmer air than an open-circuit diver would; this is of great benefit when diving in cold water. The oxygen monitors allow the diver to keep the level of oxygen at the optimal level throughout the dive and coupled with a dive computer this means that decompression obligations can be greatly reduced compared to normal open circuit diving. Furthermore, the bubbles produced by conventional scuba diving may disturb any sediment on the cave roof and cause it to 'rain' silt, reducing visibility. Rebreather diving produces very few bubbles and hence virtually eliminates this problem.

Rebreather testing prior to diving. **Photo: Phil Rowsell**

Redundancy is a critical word in the planning of any cave dive, a sound philosophy being, if the failure of a single piece of kit is likely to significantly compromise the safe return of the diver, then at least one completely redundant 'copy' of that kit should be taken on the dive. No one in their right mind would dive with a rebreather as a sole form of gas. On the dive in Castleguard the plan was to augment the rebreather with two completely independent cylinders of open-circuit scuba to be used as bail-out gas in the event of a rebreather failure. This approach has the distinct advantage that only two large cylinders would be required for the dive, where as if open-circuit was used each dive would require progressively more and larger cylinders. Due to the remote location of Castleguard Cave, and the arduous approach to it, reducing the number of cylinders is clearly a priority.

All of the commercially available rebreather units are mounted on the diver's back and are too bulky for the diving anticipated in Castleguard. Also they do not strip down easily into small parts for the carry to the sump. A small hybrid rebreather was constructed which can be mounted on the diver's chest, and most importantly can be dismantled into small parts for efficient packing and safe transportation.

Bail-out cylinders of 80 cu ft capacity were to be used. These would not be filled with air but a nitrox mixture consisting of 36% oxygen and 64% nitrogen. On any dive the diver absorbs nitrogen in body tissues and the longer and deeper the dive the more nitrogen is absorbed. Upon returning to the surface the nitrogen leaves the body tissues, this must be done at a carefully controlled rate otherwise bubbles can form in the body leading to the notorious 'Bends'. The less nitrogen there is in the gas mix the less will be absorbed, and consequently the shorter the decompression obligation. For a quick comparison the so called no stop time (where no decompression penalty is incurred) for normal air dives at sea level at a depth of 24 meters is 30 minutes, on 36% nitrox this time is extended to 43 minutes. In the cold waters anticipated in Castleguard being able to leave the water as efficiently as possible is an important consideration.

With a minimal increase in kit (carbon dioxide absorbent and small oxygen cylinders) the rebreather opens up the possibility of doing multiple dives. An extra rebreather dive requires approximately 5kg of extra kit compared to the 40kg plus required for a second open-circuit dive. The numbers speak for themselves.

Thermal Insulation

It was a major concern when planning the dives in Castleguard of how to keep the diver warm. This is especially critical once the dive duration exceeds an hour. Any decompression stops, where the diver is stationary in the water, or long periods of surveying passage where the activity level has dropped, are cause for concern. It is not simply a matter of comfort; a cold diver is far more susceptible to decompression sickness. As with any exposure to cold the extremities are the first parts of the body to suffer and diving is no exception. Numb fingers will mean that the diver can no longer perform critical tasks such as line management, valve operations and so on; this must be avoided at all costs. It is for this reason dry-gloves are mandatory for diving in Castleguard.

Some time was spent deciding whether to use a heated under-suit for the diving, however once sponsorship had been obtained from Fourth Element Ltd for underclothing it was decided that more layers of clothes, which could also be used to camp in, would far outweigh the bulky battery packs which would be required to drive an thermal under-suit. Discussions with divers who use heated jackets suggest that a 36 Ah battery pack is required for 4-5 hours use, the inclusion of such an item, based on its weight, was not practical for Castleguard. The thermal layers were augmented with a very simple piece of rubber door matting on the chest which has the same effect as an insulating ground mat for camping. The chest region is far more susceptible to cold on a dive because air migrates upwards to the back region leaving the dry-suit compressed onto the chest minimising the gap between diver and water. The mat widens this gap and from personal experience it is equivalent to an additional thick thermal layer. Ice dives of up to 1 hour duration in the Brecon Beacons National Park, Wales, in water of 2^{o}C, confirmed that this approach to diver insulation was up to the task.

Agenda

Within the allowed time frame and taking into account the fact that some days were required to sort equipment and rations it was decided that seven days would be allocated for the time in the field. The planned schedule is outlined in following table: -

Day	Event
1	Ski to the cave entrance and set up base camp.
2	Transport dive equipment to the sump, set up and test all items
3	Dive 1
4	Dive 2

5	Dive 3 (or rest day)
6	Transport equipment back to the cave entrance
7	Ski out

Allowing time for up to three dives meant there was some leeway in the schedule should events not go to plan. In any case, the team would plan to have food for an extra day so two dives should certainly be achieved.

With this plan in mind it was estimated that a minimum team size of 6 strong people would be required for a realistic chance of a successful expedition. Fortunately five very strong U.K. cavers were recruited to the team, two of whom were experienced cave divers. Ian McKenzie took on the initial vital role of recruiting members of the A.S.S. and so having sufficient personnel in total was not anticipated to be a problem.

2) Rescue Planning

With sufficiently experienced people the chances of a rescue scenario are low, but obviously with any adventurous activity there is still scope for problems. Quite rightly, before access could be granted a practical response plan to any foreseeable incident had to be formulated. Due to the remote location of the cave the principal aim was for the team to be as self sufficient as possible and to have the required skills and individuals to deal with most issues that may arise. Any external response team would likely need to be vi a helicopter.

Needless to say the team would have an Iridium Satellite phone at the cave entrance so rapid communication with the outside world was possible. Four of the six U.K. team members were trained in advanced first aid and are Wardens within their respective U.K. caving regions. They are regularly involved in rescue practices and all have taken part in serious cave rescues in the U.K. One of the team members, Rich Hudson, took on the task of putting together a comprehensive first aid kit.

Discussions where held with Phil Whitfield of the British Columbia Cave Rescue Organisation where the offer of loaning a stretcher which could double up as a sledge potentially solved the issue of evacuating an immobile casualty from the cave.

The most interesting cases which had to be tackled were those relating to potential diving incidents. These can be categorised into two types: -

1. Diver surfaces with some kind of injury;

2. Diver fails to return well after the planned dive time.

The first is relatively easy to deal with potentially only being little more complicated than a general casualty, with the worst case scenario being an immobilized diver. In this case the same evacuation plan would be brought into play as for an immobilised dry caver. The most likely cause of diver immobility would be decompression illness. Conservative dive planning, aided by the use of a rebreather, to minimize the possibility of the so called Bends is the best measure. Oxygen is the primary source of first aid for a diver with the Bends; the use of the rebreather means that there will be plenty of oxygen at hand. The next measure is the evacuation of the diver, firstly to the cave entrance and then to a decompression chamber.

In the second type of incident where the diver does not return is potentially more problematic to deal with, partly because Canada has a limited number of active cave divers and more importantly they are a significant distance from Alberta, hence considerably delaying their potential deployment. Having dive rescue facilities at hand at the cave would cripple an expedition which is based around man power only; it would certainly have put the expedition into the 'helicopter required' category. Even then, a huge amount of extra kit would have to be carried through the cave to the sump, and most likely would not be used. This approach is completely impractical for a low impact, alpinist type expedition. A sensible compromise was reached utilizing the fact that the team planned to have a reserve diver, Gareth Davies, on the team. A complete set of diving equipment was stored ready to be transported to the cave entrance by helicopter to allow the reserve diver to initiate a search in the sump should the lead diver fail to return. In the end, with the late addition of experienced cave diver Andre Whitehouse (Calgary) to the team, there were two sets of

dive kit on standby. In the event of an incident the team already at the cave would act as the sherpa team to transport the required equipment to the sump.

In the unlikely event of extra help being required, initially, any local cavers who were to be or had already been involved in the trip would be called and finally, if more people were required, the normal cave rescue call-out list, held by Phil Whitfield, would be brought into action.

Arriving at this plan took quite a number of exchanges of long e-mails, but proved to be a useful exercise for all involved. Having agreed on the rescue plan, access to the cave was provisionally granted.

3) Recruitment

Based on previous expedition experience it was decided from an early stage that the safest bet would be to arrive in Canada with sufficient people so that the expedition could be conducted in a self-contained manner. Even though it was clear that significant local assistance was available from the A.S.S. with Ian McKenzie and Chas Yonge running the recruitment, this seemed a prudent approach.

Recruitment of U.K. people proved easier than expected with 5 of the 9 individuals approached joining the expedition. The main criterion for recruitment fitness, but needless to say all of the team members were highly experienced cavers (several of them having caved significantly longer than me). The people recruited had a wealth of cave rescue experience, and most are qualified in First Aid to a high level. All team members have diving experience to varying degrees but three of the five support team are experienced cave divers in their own right, which is a huge help for the lead diver. Of critical importance was that the team would gel and work together under the harsh conditions Castleguard would throw at us. I personally had caved with each member of the support team but some did not know each other prior to the trip; I was confident that they were the type of people who would work well together. The remote nature of Castleguard and the unique experience it offered was a key factor in making recruitment easy.

UK Personnel

Alan Braybrooke has been a member of South Wales Caving Club (S.W.C.C.) for over fifteen years. He has led three successful caving expeditions to the jungles of Belize. He is a respected warden for the West Brecon Cave Rescue team. He works as an outdoor activities co-ordinator and is trained in winter mountain travel.

Alan in the ice crawl: Photo Jules Carter.

Jules Carter has been caving for in the U.K. and around the World for over 20 years. He is a member of S.W.C.C. and is a Warden for the West Brecon Cave Rescue Team. He is also a seasoned cave photographer and is skilled in cross-country skiing. He works as a biologist at Cardiff University.

Jules in camp. Photo Alan Braybrooke.

Gareth Davies (reserve diver at Castleguard) is a member of S.W.C.C. and the Cave Diving Group (C.D.G.) He is an active cave explorer in South Wales, has explored caves in Malaysia and dived in France.

Gareth in the Subway. Photo Phil Rowsell.

Rich Hudson is an experienced caver and cave diver and is a member of the C.D.G. He has taken part in numerous expeditions around the World including the famous Wakulla II project and the Cheve 2002, organised by Bill Stone. He is a rescue Warden for the Wharfdale Cave Rescue Team.

Rich on Mount Castleguard. Photo Jules Carter.

Phil Rowsell, is a member of the Bristol Exploration Club (B.E.C.) and C.D.G., he has been an instrumental part of numerous caving expeditions around the World, from Tasmania to Austria. As well as being an extremely talented caver he is a highly accomplished and dedicated cave surveyor and has made a major contribution to the mapping of the cave systems beneath the Dachestein Massif in Austria and Tasmania. He is also a key member of the Mendip Cave Rescue Organisation.

Phil in the Subway. Photo Gareth Davies.

4) Training and Preparations

The team were under no illusion that to stand a good chance of success at Castleguard would require meticulous planning, both in terms of physical fitness and dive training.

Physical Fitness

Limited access to snow makes preparation for skiing in the U.K. somewhat difficult, however from the reconnaissance trip it was acknowledged that the ski to Castleguard is more about fitness than skill and technique and all U.K. team members spent time building up their individual fitness by running, cycling, gym work and caving. A fortuitous week of snow in the UK did allow a few of the team members time to practice some cross-country skiing about six weeks before departure. Phil and Rich having more freedom in terms of work commitments decided to arrive in Canada a week before the other U.K. people to practice skiing and further build up their fitness.

Practicing sledge hauling in Wales. Photo Krysia Groves

Ice diving in Wales. Photo Krysia Groves.

Dive Training

Due to the sheer amount of effort and commitment required by the support team it was absolutely critical that the lead diver and his equipment were in top form to ensure the maximum chance of success. If someone wants to run a marathon they simply have to put the quality miles in and the same philosophy was applied to the Castleguard dive, quality time spent underwater equates to a better chance of success. This year alone the lead diver has spent over 48 hours underwater, mostly diving in a flooded mine, quarries and mountain lakes. Much of this time was spent using exactly the same kit as was planned to

be used in the dive at Castleguard. Many of the dives were in excess of two hours and a number in excess of three, to build up mental and physical resilience to long exposures and long penetrations. All training dives were designed with a specific task in mind and many involved intensive line management tasks (made more difficult with the mandatory dry-gloves required for the Castleguard dive). Others involved practising underwater surveying skills to maximise speed without comprising accuracy.

5) Funding

A trans-Atlantic caving expedition is never going to be cheap, add a diving objective and the cost is even greater. Expenditure included air fares, vehicle rental, cylinder hire, ski rental, accommodation bills and more. Fortunately there are avenues within the UK and Wales that can ease the expense of expeditions. The well known Ghar Parau Foundation, which funds overseas caving expedition, looked favourably on the venture and granted their top award. Expeditions with a large Welsh contingent are given the opportunity to apply for Overseas Grants from the Welsh Sports Council. Again the remote nature of Castleguard Cave clearly captivated the imagination of the review panel during the compulsory presentation, part of the application process, because the expedition was granted their top award. Such funding was a huge boost to the expedition as it significantly eased the overheads incurred.

To dive safely in Castleguard Cave requires top quality equipment, especially the dry-suit and under-clothing required to keep warm and insulated against the elements. Fortunately a request to Fourth Element Clothing resulted in top quality under-clothing sponsorship for the lead diver. This was rapidly followed by a sponsorship offer from Otter Watersports for a dry-suit to be used on expedition to Castleguard (and Austria). Acquisition of this kit was a definite bonus for the trip. Support and a great deal of help was supplied by Bristol Channel Diving Ltd; their technical expertise was of enormous benefit in ensuring the equipment was well prepared and reliable for the trip.

The 2009 Trip

1) Organisation

The finer points of the 2009 trip only fell into place with the indispensable assistance of Greg Horne in finalising permit arrangements, Ian McKenzie for his recruitment drive and Chas Yonge for taking over the organisation of the Canadian contingent just before the expedition. To these people we are truly grateful.

The trip was to be split into three phases,

- An initial trail-breaking trip transporting some equipment to the cave,
- The main phase of the trip to set up and conduct the diving,
- The de-rig trip,

The U.K. team members would be based at the cave for the duration of the second and third phases (a total field time of one week), with a different group of Canadian cavers taking part in each phase. This plan has the greatest benefit in that there are always fresh people at the cave. In addition it also allowed a large number of Canadian cavers the opportunity to participate in the expedition and to see some of Castleguard Cave.

2) Trail Breaking Trip (3^{rd} – 7^{th} April)

Chas Yonge took on the role of organising and leading the trail braking trip. The team objectives were to cut a trail to the cave, to rig the entrance pitch, check that the ice-crawl was open and to transport some diving and camping equipment to the cave. Chas was accompanied by Matt Tuck, Eric von Laue, Bill Boley, Elen Rees, Scott Hall, Claire Gougeon, Don Kulak and Rich Hudson together with Phil Rowsell from the U.K.

Don had to turn back early due to a ski binding failure, but otherwise the team had a successful trip to the cave with some 20kg of essential dive kit, Rich and Phil's camping kit,

the S.A.T. phone and First Aid Kit, left at the cave ready for the main phase. The ice-crawl was found to be comfortably open which was a great relief.

Phil, Rich and Eric left the cave on the 5th April so that they could meet up with the rest of the U.K. team to prepare for the main phase of the expedition.

Many thanks to all involved, without their support at this stage the subsequent phases of the expedition would have been much more difficult.

Members of the trail-breaking trip at the cave entrance. Photo Rich Hudson.

3) Set Up and Dive Phase (8th – 11th April)

The plan was for the six members U.K. team members to be accompanied by Nate de Bock, Kevin Abma, Chantelle Tregunna, Monique Castonguay and Andre Whitehouse. Andre had joined the team only a couple of weeks prior to the start but proved to be of great assistance, being an experienced cave diver himself. He also agreed to act as an emergency response diver and had a complete set of diving equipment stored and ready at Chas's house in the event of any emergency.

The whole team met at the Big Bend just after first light; Chantelle was feeling unwell and had to drop out of the trip. Luckily Nate, Kevin and Monique had almost empty sledges which could be used to fit additional equipment in where at one stage it may have been difficult, owing more to bulk rather than weight of kit. Everyone was using a back-pack sledge combination, with modified children's sledges. The principal problem with these sledges is that the centre of gravity must be kept very low, to avoid toppling; this restricts the amount of bulk which can be transported per person.

The team made steady progress to the cave, but afternoon sunshine made for a dehydrating trip.

Skiing up the glacier. **Photo Martin Groves.**

Once camp had been established the rest of the evening was spent finalising packaging of the dive kit ready for the carry-in the next day. The dreaded portering day soon arrived, all team members helped in transporting large loads to the sump. The most difficult objects to be carried were the bail-out 80cuft diving cylinders which weighed in at around 20kg each. (Luckily I had the task of carrying the bulky, but lighter rebreather due to its delicate

nature.) Full credit must go to the team for transporting such difficult loads through the awkward terrain along Boon's Blunder.

To protect the cylinders they were wrapped in foam sleeping mat, with the main on/off valve exposed so that its position was known and could be monitored at all times. Particularly unpleasant was the unexpected surprise that parts of the ice-crawl had begun to melt. Once a few people had travelled through with large bags it was turned to a slushy crawl, which was unpleasant when wearing thin cotton coveralls. Luckily, as a matter of course, the dry-suit and underclothing were transported in dry bags, so they remained dry ready for the dive. Of particular concern for diving operations was the possibility of catching a cold whilst after been exposed in the slush. Fortunately, a cold spell over the following few days meant much of the ice-crawl re-froze. A visit to the cave any later in the year can not be recommended.

Once all of the kit had arrived at the sump several hours were spent setting it up and running through the critical safety checks. The rebreather canister was filled with sofnolime and the rebreather assembled. Both positive and negative pressure checks were run on the rebreather to test for leaks. For a positive pressure test the rebreather was fully inflated and then monitored over a period of twenty minutes to ensure there was no deflation. A negative pressure test involved sucking all of the gas out of the rebreather, shutting it off and checking that it does not begin to re-inflate. Both these tests are critical to ensure the rebreather will not leak water when submerged. The rebreather oxygen meters and gas addition systems were also checked to ensure they were performing correctly. Due to the altitude of the cave, and hence lower air pressure, the oxygen meters, which were calibrated at sea level, had actually dropped. This was expected and providing the two independent units agreed, was of no cause for concern. (The oxygen meters measure the partial pressure of oxygen not the percentage oxygen in the air).

The all important bail-out cylinders were valved up and checked. These cylinders contained a nitrox mix of 36% oxygen and 64% nitrogen. The cylinders also had the critical role of providing the diluent gas to the rebreather and gas to inflate the dry-suit to control the diver's buoyancy.

During the setting up Andre decided to dip one of the dive computers into the sump to check the temperature. To everyone's surprise he recorded a temperature of 4^{o}C! Initially hard to believe, but this unexpected (and welcome) warmer temperature meant that having planned for diving in 1^{o}C water , 4^{o}C would be markedly more comfortable, and more importantly, where diving regulators are known to sometimes freeze up at low temperatures, 4^{o}C is above this danger threshold.

Phil assists Martin into the sump. Photo Jules Carter.

With all of the kit carefully assembled a steady trip was made back to camp to rest and focus on the business of diving the next day. A disturbed night's sleep was caused by a couple of pesky pine martens who raided the camp during the early hours of the morning.

A trip to the sump followed the next morning, with a few items of extra kit transported in. The equipment checks were quickly run through again, before the process of kitting up. The nature of the sump pool, a 10m long and 1m wide rift with the water level 1.5m or so below the ground level makes for tricky entry to the water. The only sensible place to kit up is near water level at one end of the pool. The area is uncomfortable and cramped and assistance is essential whilst kitting up. Dry gloves were donned after the dry-suit and harness to ensure an effective water tight seal is obtained; this meant, however, that dexterity was lost and it was difficult to continue and complete kit up. Phil Rowsell did a sterling job of ensuring that all 70kg of kit was correctly configured before he and Andre eased entry into the water. After a year of planning, the swim across to the original dive line was somewhat apprehensive; so much time and effort had been put in by so many people, it was essential that full focus was given to the task at hand. Being surrounded by long standing friends, cracking jokes and lightening the mood certainly helped and a better bunch of people to help could not have been wished for. Alan lowered the line reel into the water while Jules and Phil continued to snap away with their camera. Anticipating a line break at the bottom of the shaft a decision was made to run a new tagged line from the surface. With the rebreather mouthpiece in place a muffled, "See you later", received the jestful reply of, "Get on with it!"

Turning away from the team I finned slowly into the turquoise water. I always knew that this first part of the dive was going to be the most difficult part and knew I had to concentrate fully. Difficulties to be encountered involved managing the line, controlling buoyancy by inflating air into the dry-suit and most importantly monitoring the gas in the rebreather, all whilst descending the vertical shaft. If insufficient gas is injected into the rebreather it is impossible to take a full breath, too much causes the cheeks to expand and gas to be forcibly vented. The relevant techniques had been practiced many times in the U.K. in poor visibility, in Castleguard the visibility was a good but it was still a relief to reach a pile of silt, at 19m depth at the bottom of the shaft. A quick check was made of the oxygen

levels and buoyancy before the old line beckoned the way forward beneath a cobbled arch into the main tunnel. The sight was inspirational, effectively unlimited visibility in a tunnel some 10m wide by 3m high heading off as far as the lights could penetrate. Rapid progress was made to the line reel left by Sawatzky in 1985 with only one line break been encountered at about 110m into the sump at and a depth of 16m. There were numerous elongated rocks scattered on the floor which made perfect belays by wrapping the line around them. There was a fine dusting of sediment on the floor which stirred up on passing but not enough to cause any major concerns. Continuing into the unknown the passage became more rift like in nature 3m wide by 4m high with a couple of sweeping bends. All too soon the 240m line reel ran out, the line was secured to a large boulder with a large loop left floating to which a new line could be attached. About 5m ahead a sharp left hand bend was visible and the rift looked as if it was narrowing down. The sump had risen to a depth of 13m. It was impossible to resist a look to the left and so a 50m search reel enabled a 30m run-out of line; the passage continued in the same vein so the untagged line was reeled in and a slow exit began. Some time was spent tidying up the old line and where ever possible clipping it onto the new line, 20m of old line was collected and removed from the sump. Back at the arch the visibility was down to zero, clunking through the only low section of the sump caused no real problems. A slow ascent was made with a 2 minute safety stop at 6m, even though neither dive computer had registered decompression requirements.

Surfacing after 57 minutes with an empty line reel was hugely satisfying and was a massive morale boost to the cold support team who jumped straight into action getting a hot drink on and helping me out of the water. I felt enormous relief having made good progress in the sump, but was aware that I could not fully relax because tomorrow I would be going further.

Surfacing after the first dive. **Photo Phil Rowsell.**

Quite a while was spent talking about the dive and then people started to make their way out of the cave. A few went off to look at and photograph the subway. Andre and I stayed to replace the chemicals in the rebreather and get all of the equipment ready for tomorrow's dive. We slowly made our way out of the cave, just enjoying ourselves and generally gossiping, there was no rush.

There was certainly a good buzz around the camp that evening and it was great to see Don arrive. Another disturbed sleep was had thanks to the pine martens. The next morning we said farewell to Nate, Kevin, Monique, Andre and Don who were skiing out. These guys kindly carried the rubbish out and a big thanks goes to Monique who happily transported the human waste without a grumble! This was all essential weight and such efforts went a long way towards alleviating the demands of the final ski out. Nate and Kevin also kindly swapped their larger sledges with ours in preparation for the de-rig ski out.

Gareth and Phil had a well deserved break from 'sump duty' and took a tourist trip into the main section of the cave, whilst Jules, Alan, Rich and I made our way once again to the sump. A further 270m line was loaded onto the reel. The kitting up process was repeated,

this time Rich did a fantastic job of ensuring all was well whilst Alan passed the kit to him, and meanwhile Jules continued to take photographs. It was a great relief to actually get into the water a feel weightless after the toil of the preceding days, the actual diving is the least physically demanding part of the trip. Submerging again, after a false start with a minor dry-suit inflation issue that was quickly resolved, rapid progress was made to the previous day's limit. The visibility in the main tunnel had mostly recovered, it was only at the bottom of the pot that the visibility was very poor but this caused no particular problem. With the new line attached at the 240m mark the passage continued in its rift like manner with the occasional section taking on a bedding type nature, a couple of short oxbows were passed but there were definitely no side passages. One slightly low section was passed with a hard clay floor, which formed 'castle-like' sediment formations before the passage resumed its familiar rift. All too soon, after 50 minutes underwater and at a depth of just 6m the line ran out at a convenient boulder. The line was secured and a minute or so was spent looking longingly at the continuation. The passage gave the appearance of belling out into a chamber some 10m beyond. Although tempted I decided not to attach the search reel and go further to look. At this point it became evident that a return was a must, but at this time efforts were to be channelled into the task of surveying the sump already passed through.

On the inward dive belays were intentionally placed near to line tags and to maximise the number of long straight sections thereby easing the survey process. A small survey board with a compass mounted on it was used, together with the digital depth gauge on the dive computer. It was better to spend time on getting an accurate centre line instead of spending time sketching passage details and at each station care was taken to get as accurate a compass reading as possible. The outward swim was slow but pleasant even though the cold had chilled the fingers noticeable by the time the arch at the base of the shaft was reached.

Again, due to the shallow depth of the dive no decompression was incurred, nevertheless a few minutes of safety stops at 6m with the rebreather flushed with pure oxygen were undertaken, just to be 'kind to my body'. It was with relief and satisfaction that the surface was reached after 1hour 45minutes away from dive base, returning with an empty line reel and 508m of survey data. Again the lads performed flawlessly in the de-kit routine and getting brews on, whilst listening to a detailed recount of details of the dive.

With no line left and limited oxygen supplies another push at the end was out of the question. The idea of using the search reel on an open circuit dive downstream was considered but it was finally decided enough was enough for this trip and that, for the moment, the fins could be hung up with satisfaction. With the decision made it was agreed that each team member would pull a decent sized bag of dive kit out of the cave. Alan and Rich speedily left the cave and Jules was kind enough to cave out more slowly with me; I felt a little light headed on the way out, but more so I was more in the mood for taking it easy and savouring the moment. The diving operations were over and at last I could really relax.

4) The De-rig (12th – 15th April)

With the diving now complete the task of removing all of the equipment from the cave and then back to the trail head had to commence. Mistakenly thinking that the third phase of Canadian cavers were due to arrive on the 11th April caused some concern when no one was to be seen by evening, suggesting that the de-rig would turn into a real mission! The following morning was somewhat fraught with discussions on the best way to go about de-rigging. Most people wanted a break from the cave. A trip to the sump to pull out the large diving cylinders was not the most joyful part of the expedition, but a job that needed doing, and I must thank Phil for coming on the trip. The other U.K. team members took a well deserved break from the cave and chose to ski towards the summit of Mount Castleguard but were forced back by poor weather.

It was with great relief upon reaching the entrance gate to the cave to see that the number of people at the camp had doubled; the cavalry had arrived! (A small mistake on the dates.) The strong support team that arrived consisted of Gavin Elsley, Chris Stenner, Colin Massey, Jesse Martin, Nicholaus Vieira. A pleasant evening was spent in camp gossiping about caving and formulating a vague plan for the next/final phase of the expedition.

Next morning arrived all too soon. A lot of kit had already been pulled back from the sump which meant that not everyone needed to experience the ‘pleasure’ of Boon’s Blunder. Gareth, Gavin, Chris and Nicholaus took on the essential but unenviable job of fetching the

remaining equipment from the sump. In the meantime the rest had the fun task of trips to camp 1 area of the cave. Exceptional gratitude goes to those who de-rigged and allowed me the chance to go to camp 1; I think a 5th consecutive day in Boon's Blunder would have done terminal damage to my knees!

With all the kit successfully back at the entrance, it was quickly packed into bags and left in a sensible order for people to decide what could be fitted into their sledges. The cave was left a day earlier than planned.

An unexpected surprise came that evening with the arrival of Chas, Bev and Scott; another evening was spent in lively conversation. Now there was an exceptionally strong team for the ski out - a huge relief.

The following morning saw decamp, packed sledges and a staggered exit from the cave. Conditions were good for the ski out, yet all were eager to reach the trail head and visit the pub in Lake Louise for a few well earned beers. A scary realisation was that even before aches and pains had subsided a plan was already formulating for a return trip!

The mass exodus from the cave. **Photo Jules Carter.**

The only equipment to be left at the cave was the lead weights, which have been placed on a ledge on the right hand wall just after the gate. Since a return trip had already been discussed carrying out the lead weights would be ludicrous.

It is essential at this point to convey sincere thanks to everyone who was involved in the trip; without each person's contribution it would not have happened. It was my intention to mention everyone involved in person therefore I extend apologies should there be any omissions.

Findings

1) Summary of Finds

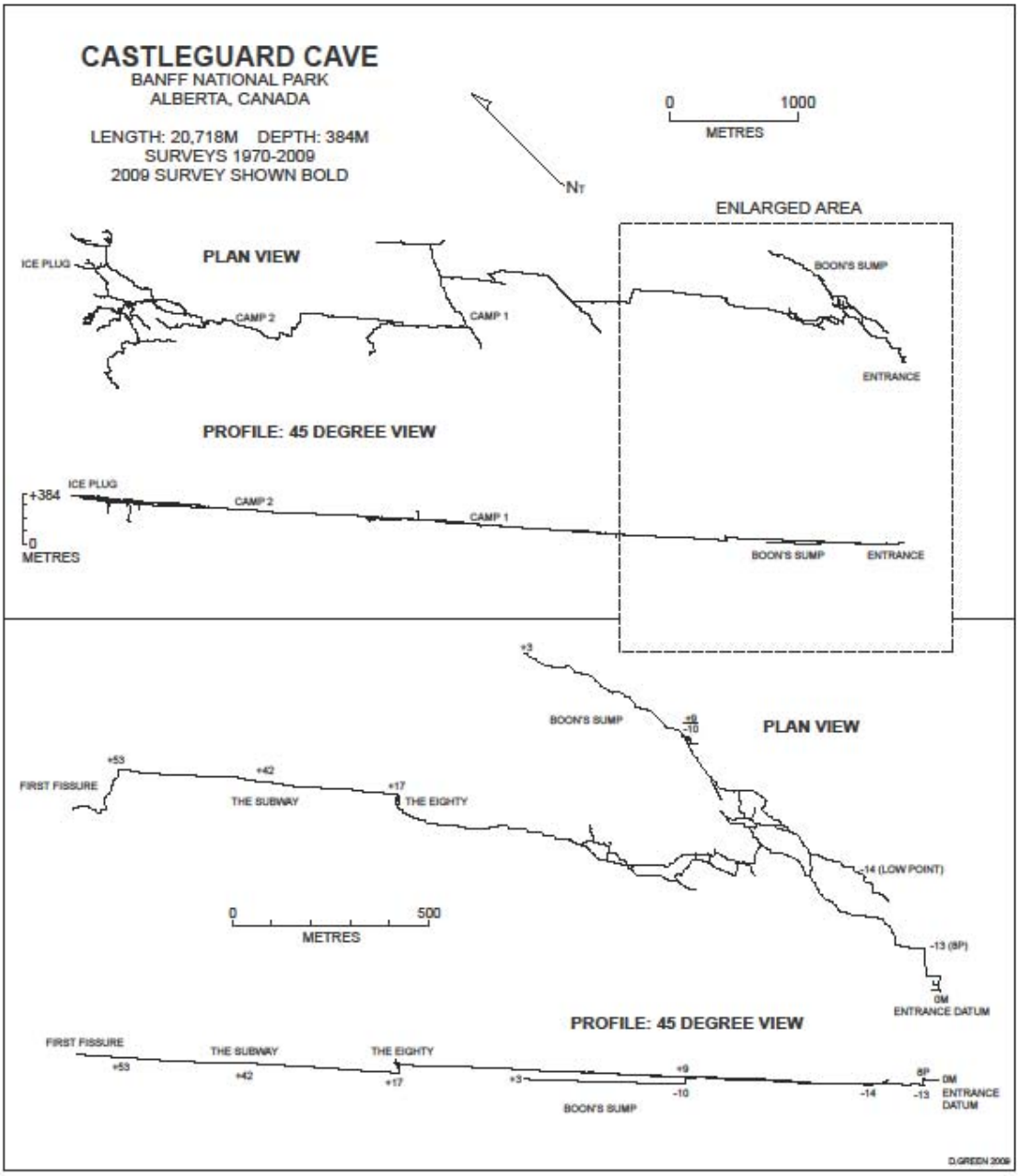
In summary, over the course of two dives 508m of line was laid in the upstream passage of the sump at the end of Boon's Blunder. The sump initially descends to a depth of 19m and gradually rises to a depth of 6m at the present limit of exploration. Provided this current trend continues then the sump can be expected to break surface after a further 250-300m. The main conduit starts off as a 10mx2m bedding plane but at the limit of exploration has changed into a rift like passage of 1mx3m dimensions. The inwards visibility was effectively limited by the power of the diving lamps and the return visibility was typically about 5m, except in a couple of places. Generally the bed rock only contained a thin layer of fine silt which stirs up easily so careful diving is a must. The visibility cleared over night between dives, implying there is a current in the passage, although it could not be physically detected.

It was of interest to see that the original dive line for 80's was intact except for one break. This suggests that the water level in the sump rises gradually and there are no ferocious flood pulses in the main conduit.

The final point of real significance was the fact that the water in the sump was 5^0C, much warmer than expected and a potential mystery to solve in the future. With Chas's help the dive computer calibration was checked when back in Canmore to confirm the reading at the sump was correct.

2) Survey

Any cave exploration is of limited or no value if the finds are not surveyed. Knowing clearly the trend of the passage in the sump is of great interest to cavers. To survey underwater caves the diver uses tagged dive line to measure distance, a compass to measure bearings and a dive computer to measure the depth at each station.



Boon's Sump together with the 2009 extensions on the Castleguard Cave Survey

The dive line was tagged at 5m intervals, with the line deliberately belayed close to distance markers to minimise over or under estimation. The compass used was a conventional one mounted on a plastic board to facilitate ease of alignment with the dive line, giving an accurate angle value. A conventional dive computer measured depth to the nearest 10cm, recorded at each station.

Due to dive time restriction and the fact that the passage is fairly simple in nature with no side passages it was decided available time would be most effectively spent obtaining a quality centre line of the sump and not in drawing passage details. It took approximately an hour to survey the total 508m of passage on the second dive.

The survey data was passed onto Dan Green, who has done an exceptional job of compiling the navigatable pdf map of Castleguard Cave. He quickly produced the plots recorded.

The sump generally heads beneath the Castleguard Meadows and not towards any known section of cave. This raises the exciting possibility that it may surface in a whole new section of cave which parallels the known system. There is only one way to find out for sure!

Overview

In conclusion the combined UK and Canadian expedition successfully explored the sump at the end of Boon's Blunder passage to a distance of 508m from base. The sump is still wide open heading beneath the Castleguard Meadows. The team has demonstrated that it is possible to achieve such an objective in a low impact manner using person power alone, but only with the dedication of a large and physically capable support team.

The recorded water temperature is of specific interest when discovered that the water in the sump is significantly warmer than expected. This opens up the mystery of where the warmth emanates from, alongside the question of what might lie beyond the sump. There is only one way to find out for certain and that is to continue exploration.

Future

The success of the expedition and the questions it has posed warrants a return trip. The current kit configuration would easily allow a penetration of 800m into the sump, especially if the current upward trend of the passage continues.

An added interest is that of the downstream passage which was not touched on this trip. The benefit of the rebreather set up is that it will allow more dives to be conducted with only a small addition to the kit making the additional diving of the downstream passage an easy possibility.

Now that the sump is a familiar place it will be possible to look for invertebrates in its waters to further the survey conducted to date in other known parts of the cave. This may involve setting traps in the sump for retrieval on a later dive.

A further vision is to use a small helmet mounted video camera with which to record the dive allowing presentation of more detail of the passage structure and to better inform understanding of the nature of this intriguing passage.

Discussions are underway with a number of scientists regarding the idea of data logging the temperature and possibly the depth of the sump over a whole year to see what seasonal changes occur in the cave.

From an explorers point of view the prospect of surfacing into a dry extension beyond the sump is an exceptionally exciting prospect and could lead to a major extension of Castleguard Cave.

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The U.K. team members Alan Braybrooke, Julian Carter, Gareth Davies, Rich Hudson and Phil Rowsell deserve big thanks for coming on the trip and providing first rate support.

All of the Canadian cavers involved in the expedition are also be thanked for providing the three phases of support during the expedition; without this first class support the trip would certainly not have been possible, so many thanks to the A.S.S. I hope I have mentioned everyone individually in the report and humbly apologise for any omissions.

Particular thanks go to Ian McKenzie and Chas Yonge for organising the reconnaissance trip, rallying up local interest and organising the subsequent parts of the trip. It is also important to acknowledge the background work by Chas of purchasing equipment, back country passes and the cave key prior to the expedition.

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It is also important to acknowledge the behind the scenes work of Phil Whitfield and the British Columbia and Alberta Cave Rescue teams for helping to devise a sensible contingency plan. In this respect Pat Shaw is also thanked for lending essential rescue equipment.

Finally, on a more personal note I must thank Gareth Davies and Joel Corrigan for the loan of essential dive equipment and most importantly I should like to thank my wife, Krysia, for putting up with this obsession for the last year. I don't know how I will ever repay all of the carries up to the silica mines.